What is claimed is:

1. A device for pumping an electrolyte solution through a conduit, said device comprising:

a polarized ferroelectric member disposed along a portion of said conduit, with said polarized ferroelectric member positioned for interaction with the electrolyte solution; and

a means for selectively establishing a potential difference across said portion of said conduit to interact with said electrolyte solution to pump the electrolyte solution through said conduit.

2. A device as recited in claim 1 further comprising a means for selectively polarizing said ferroelectric member to charge the electrolyte solution in said portion of said conduit.

3. A device as recited in claim 2 wherein said means for polarizing said ferroelectric member comprises an electrode that is electrically connected to a direct current (DC) voltage source.

4. A device as recited in claim 1 wherein said conduit has a first end and a second end and said portion of said conduit is located between said first end and said second end, and wherein said means for establishing a potential difference across said portion of said conduit comprises:

a first electrode positioned between said first end of said conduit and said portion of said conduit;

a second electrode positioned between said second end of said conduit and said portion of said conduit; and

a means for establishing a potential difference between said first electrode and said second electrode.

5. A device as recited in claim 4 wherein said means for establishing a potential difference between said first electrode and said second electrode comprises a direct current (DC) voltage source.

6. A device as recited in claim 1 wherein said ferroelectric member is made of a ferroelectric material selected from the group consisting of a metal titanate, a metal tantalate, a metal niobate and a metal tungustate.

7. A device as recited in claim 1 further comprising a means for establishing an alternating electric field of decreasing amplitude to de-polarize said ferroelectric member.

8. A device as recited in claim 1 wherein said conduit has a first end and a second end and said portion of said conduit is located between said first end and said second end, said device further comprising:

a first electrode positioned adjacent to said ferroelectric member;

a first alternating current (AC) voltage source connected to said first electrode for polarizing said ferroelectric member;

a first driving electrode positioned between said first end of said conduit and said portion of said conduit;

a second driving electrode positioned between said second end of said conduit and said portion of said conduit; and

a second alternating current (AC) voltage source electrically connected to said first driving electrode and said second driving electrode to establish a potential difference between said first driving electrode and said second driving electrode.

9. A device as recited in claim 8 wherein a first layer of dielectric material is interposed between said first driving electrode and said electrolyte solution and a second layer of dielectric material is interposed between said second driving electrode and said electrolyte solution.

10. A device as recited in claim 9 wherein said first and second alternating current (AC) voltage sources have the same angular frequency.

11. A device as recited in claim 9 wherein said first and second alternating current (AC) voltage sources have different phase angles.

12. A system for manipulating electrolyte solutions, said system comprising:

a conduit formed with a lumen and having a first end and a second end;

a ferroelectric member formed with a surface, said ferroelectric member disposed along a portion of said conduit with said surface oriented for contact with electrolyte solution in said lumen of said conduit;

a means for polarizing said ferroelectric member to place a charge on said surface of said ferroelectric member to interact with the electrolyte solution; and

a means for establishing a potential difference across said portion of said conduit to apply a force upon electrolyte solution in said lumen of said conduit.

13. A system as recited in claim 12 wherein said conduit is a first conduit and said ferroelectric member is a first ferroelectric member and said system further comprises:

a second conduit formed with a lumen and having a first end and a second end, said first end of said second conduit connected to said first end of said first conduit at a junction with said lumen of said first conduit in fluid communication and said lumen of said second conduit at said junction;

a second ferroelectric member formed with a surface, said second ferroelectric member disposed along a portion of said second conduit with said surface oriented for contact with electrolyte solution in said lumen of said second conduit;

a means for polarizing said second ferroelectric member to place a charge on said surface of said second ferroelectric member; and

a means for establishing a potential difference across said portion of said second conduit to apply a force upon electrolyte solution in said lumen of said second conduit.

14. A system as recited in claim 13 further comprising a third conduit formed with a lumen in fluid communication with said junction for alternatively routing electrolyte solution from said third conduit between said first conduit and said second conduit.

15. A system as recited in claim 13 further comprising a first reservoir containing a first electrolyte solution and a second reservoir containing a second electrolyte solution, said first reservoir connected to said second end of said first conduit and said second reservoir connected to said second end of said second conduit for selective mixing of said first electrolyte with said second electrolyte at said junction.

16. A method for manipulating a solution having first ions and second ions, said first ions having a first charge polarity and said second ions having a charge polarity opposite said first ions, said method comprising the steps of:

providing a ferroelectric member having a surface;

placing said surface of said ferroelectric member in contact with said solution;

establishing a first electric field to polarize said ferroelectric member and create a charge on said surface of said ferroelectric member to draw said first ions towards said surface of said ferroelectric member; and

establishing a second electric field within said solution to create a force on said second ions in the direction of said second electric field and cause said solution to flow in the direction of said second electric field.

17. A method as recited in claim 16 further comprising the step of:

removing said first electric field before establishing said second electric field.

18. A method as recited in claim 16 further comprising the step of:

establishing an alternating electric field of decreasing amplitude to de-polarize said ferroelectric member to cause said solution to stop flowing in the direction of said second electric field.

19. A method as recited in claim 16 wherein the magnitude of said first and second electric fields vary with time and have the same angular frequency.